Novel Technique for Prediction of Fungal Diseases in Oilseeds

SHORT SYNOPSIS

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by

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DECLARATION BY THE SCHOLAR

I hereby declare that the short synopsis entitled "Novel Technique for Prediction of Fungal Disease in Oilseeds being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in the Department of Computer Science & Technology under the School of Engineering of Manav Rachna University, Faridabad during the academic year 2023-24. It is the work that is expected to be carried out under the supervision of Dr. Parneeta Dhaliwal.

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This is to certify that, the short synopsis entitled "Novel Technique for Prediction of Fungal Diseases in Oilseeds" is an original piece of work done by research scholar Mrs. Kiran Dhangar under the supervision of Dr. Parneeta Dhaliwal for the degree of Doctor of Philosophy in the Department of Computer Science Technology under the School of Engineering of Manav Rachna University, Faridabad during the academic year 2023-24.

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ABSTRACT

In Fungal diseases pose a significant threat to the oilseed crop industry, leading to substantial yield losses and economic consequences. Traditional methods of disease detection in crops require manual inspection, which is time-consuming and limited by human subjectivity. In recent years, deep learning techniques have shown promising approach in various agricultural applications, including disease detection. This research aims to study different models of deep learning and develop a novel deep learning technique for prediction of fungal disease in oilseeds also develop an ensemble approach for the detection of fungal diseases in oilseed crops. The objective is to identify the most accurate and efficient approach to aid farmers in timely disease management and minimize yield losses.

Oilseed crops are essential sources of edible oils, biofuels, and animal feed globally. However, they are highly susceptible to fungal infections, which can drastically impact crop productivity. Early and accurate detection of fungal diseases in oilseed crops are crucial for maintaining agricultural sustainability and ensuring food security. Deep learning, a subfield of artificial intelligence, has demonstrated remarkable performance in image recognition tasks in recent years, making it a potential solution for automated crop disease detection.

Keywords: Deep Learning, Oilseed Crops, Fungal Diseases, Disease Detection, Agriculture Sustainability.

1.Introduction

The economy of the country is significantly influenced by agricultural food crops. Health of crops has a significant impact on the productivity of the crop. However, these crops are extremely attacked by a variety of factors, including the environment, climate change, nutritional deficiencies in the soil, and plant diseases throughout the complete growth cycle [8].

Disease in crops is responsible for the damage of crops, it is a very important issue in agriculture. Due to infected plants major part of crops destroyed and it can lead to more import from other countries and it cannot be economically beneficial for any underdeveloped country.

Due to diseased plant crops quality is diminishing and also reducing the quantity of crops. The major concern of the country is to improve the production of crops and it not possible if crops are destroying due to disease. To increase the quantity of crops disease must be identified and classified accurately. With the use of advance technology like deep learning techniques disease can be identified at early stage and preventive action can be taken by the farmer, also it can lead to economic growth and stability of farm management.

In certain instances, the crop is completely tear down before the harvest period. Hence, it is vital that infectious illnesses in plants or crops are identified early on so that their spread can be controlled and appropriate measures can be taken. Proper supervision is needed at every stage of crop cultivation in order to detect illnesses and gauge their severity [5].

India imports edible oils very much and produces a lot of oilseeds. The position of India is fourth in vegetable oil economy in the world, behind the US, China, and Brazil. Oilseed build up 3% of the nation's gross domestic product and 13% of the total field under cultivation. Annual oilseed crops, comprising edible oilseeds (groundnut, rapeseed & mustard, soybean, sunflower, sesame) and non-edible oilseeds (castor and linseed), are mostly grown in the country due to its unique agro-ecological characteristics. Around 27 million hectares of the country are used for oilseed farming, mostly on marginal soils, with 72% of the land used for this purpose.

1.1 Traditional method and Modern Technology of disease detection: -

Plant pathologists with training used to visually inspect the plant tissue to find diseases in crops. Farmers and a team of agriculture professionals used to be able to spot diseased crop fields mostly by looking for visual indications on leaves or other plant parts. This approach consumes more time, is very subjective, ambiguous, expensive, and has many limitations [10– 15]. Therefore, it is no longer reliable to manually inspect for disease symptoms in crops. New models are needed since agriculture technology is advancing quickly, especially for big farmlands. Nowadays, high-resolution photographs may be captured using digital cameras and mobile devices. Remote disease diagnosis is made possible by this extensive collection of photos, current communication tools, and computer vision technology. The use of modern technology and practices in agriculture is discussed in this study [41–42].

Fungal diseases found in crops are a worthy of attention for farmers and agriculture worldwide. Fungi are diverse microorganisms that can affect various parts of plants, including leaves, stems, fruits, and roots, causing a wide range of diseases. These diseases can result in bring down crop yields, low the product quality, and economic loss.

1.2 Plant Pathology

In plant pathology, it is the study of diseases that affect plants. It is a part of agricultural science and biology that emphasis on finding the reason, mechanisms, and effect of diseases in various plants, along with it develop methods to manage and control these diseases.

Diseases in plants due to various factors, including fungi, bacteria, viruses, nematodes, phytoplasmas, and other living organism. Due to disease all types of crops can be damaged whether it is food crops or oilseed crops any kind of plants can get affected.These diseases may affect all kinds of plants, including crops, ornamental plants, trees, and natural vegetation.

In plant pathology main focus on the following points:

1. Identification of disease: There are different types of diseases that affect different crops and symptoms also different some disease can be observed visually some cannot. which agent is responsible for disease whether it is due to environment or due to living organism.
2. Understanding of Disease: As mentioned above disease can be from various factor so

to understand the real cause of disease thru which it had affected the crops. When got to know the exact reason of disease that infect the plants prevention must be done according to the crops.

3. Management of Disease: After got to know the disease plant pathologist try to control and management of disease like spread of chemicals example fungicides, bactericides and use of other biological control methods and any other disease management methods.

4.Prevention of Disease: By organizing awareness program (for disease prevention, inform about new diseases, how the disease spread etc.) for farmers Plant pathologists can prevent the occurrence of disease. By promoting food agriculture practices among farmers.

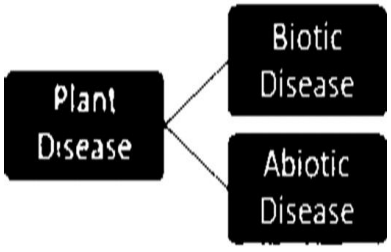
5. Research on Disease Detection: In this pathologist continuously doing research on identification and classification of disease by using various latest techniques like machine learning, remote sensing, to improve the performance and accuracy in disease detection and monitoring.

6. Sustainability: Objective of plant pathologists is to lessen the impact of diseases on crops and promote the use of techniques that does not harm the environment.

Plant pathology plays a critical role in maintaining global food security and protecting natural ecosystems. By grasping and managing plant diseases, plant pathologists contribute to the development of strong and highly-yielding agricultural systems. They also helps in reducing the economic and environmental losses due to plant diseases, and make sure a stable and healthy food supply for communities around the world.

1.3Types of Disease

In agriculture crops loss occur due to various reasons some of due to living organism like insects, virus, fungi and some of due to environmental conditions, lack of minerals in soil, excessive moisture, resulting of all this damage of large amount of crops occur.



Disease in plants occur because of pathogen. Plant disease can be divided in to two category biotic and abiotic plant disease to show which disease can occur due to which type of pathogen.

1.3.1Abiotic plant diseases: This type of disease found in crops because of non-living agents example heavy rain or low rain, variation in temperature, improper use of chemicals,

lack of minerals, environmental conditions not suitable for crops etc.[21]

1.3.2Biotic Disease: This type of disease occurs in plants because of many types of living organisms like fungi, virus, bacteria etc. These organisms take the support of plant and grow themselves by absorbing nutrients from plant needed for their life.[22],[23]

2. Literature Review:

Method given in the paper [1] uses image augmentation to enhance the size of the dataset after gathering the photographs. Deep learning is used for classification. If the developed model's accuracy from our model is good, then illness identification can be generated; otherwise, parameter optimization needs to be adjusted.

Outcome of the research [4] showed that PCA-SVM, followed by SMLR-SVM, performed the best for the study region among the six models generated for mustard yield prediction in various zones of Rajasthan.

In this research [35]the author has collected dataset of early blight disease of tomato from agriculture research institute. Proposed approach performs very good on the above dataset. Validation done on the plant village dataset . at the end the EfNet-B3-ADB and EfNet-B3-SGB perform on all three datasets, this research is very helpful for farmer to cure from disease.

In this research the author used hybrid ensemble approach. the integration of various machine learning algorithms results and it shows good performance to the result of single algorithm. The results found better disease classification in oilseed with the ensemble-Vote in new hybrid ensemble approach. [5].

In this research[13] detect disease found in mustard plants. CNN approach is best for disease classification used in this research .Dataset made using different image augmentation techniques contain 47760 images. Deep separable convolution layer along with inception modules provide accuracy of 97.11%.

The aim of this research [14] is to identify the disease accurately. Based on the characteristics of fugal disease it identifies disease at early stage, this is the main attraction of this research.

Image processing technique shows better performance in detection of fungal disease other than traditional techniques.

In this research [15] Anthracnose, Bacterial wilt, Fusarium wilt, Verticillium wilt, Downey mildew etc. fungal disease detected in oilseeds using Deep Learning classifier Ensemble Particle Swarm Optimization, Vote. The results provide achieved the accuracy of 96%.

In this research[10] the main focus of researcher on a new deep learning approach to identify disease in peanut leaf. An improved version of X-ception with the combination of module of parts-activated feature fusion have been used.

The segmentation done using k-means clustering method and classification is performed by convolution neural network method , image processing is done before this . Segmentation and classification perform on grey scale images of infected leaves. Groundnut leaf images are enhanced more to extract the features and Convolution Neural Network classifier is used for detection and classification of disease in groundnut leaves.[2]

In this research [3] dataset taken from plant village dataset to detect groundnut leaf disease. It has been used for training and testing purpose. DCNN approach is used to train and test the dataset, Stochastic gradient momentum used to train the dataset, DCNN gave accuracy 94.96% in state of art comparison method, maximum pooling accuracy 94.95% and by average pooling got 94.83%. if make a comparison with other layers of DCNN, the rate of accuracy of 6^{th} layer is 95.28%, overall, it shows better performance in detection of groundnut leaf disease in comparison to other traditional methods.

Three dimensional deep learning model has been deployed on the dataset for disease detection in plants . Three dimensional deep learning model has a accuracy in classification of disease 95.73% [11].

This is a review paper that show the use of UAV based remote sensing techniques for disease identification, with advanced artificial intelligence techniques. First section describes the different sensors and image processing techniques used in machine learning how it accurately identifies the disease. Second it gave the taxonomy and divide in category the already done work on disease detection in plants using image taken by UAV. In the third step it analyzes the execution of different machine learning and deep learning method for identification of disease in crops, in final step what are challenges occur with the uses of UAV based remote sensing techniques for disease identification. [12].

In this research [6] various machine algorithm used for disease identification and for classification of disease. This paper identifies the charcoal rot disease in soyabean plant. This paper mainly uses physiological and morphological features. The comparison of six types of machine learning techniques has been done for prediction of charcoal rot disease. when consider different metrics for evaluation the result shows that GBT and SVM shows equal performance and shows better performance in comparison to LR-L1, LR-L2, RF methods.

This research [37] detect disease of sunflower leaf. Small dataset of infected and healthy leaf of sunflower has been used for detection of disease. The hybrid model of transfer learning and CNN has been used. Eight models have been tested of four classes. From this the hybrid model of VGG19+CNN gives the best result in terms of performance metrics(precision , recall, F1 score etc.). Accuracy is 93% on small dataset, provide better accuracy in comparison of other approaches. In future scope the large dataset can be used for disease detection.

In this study[38] author has develop an algorithm to detect disease in sunflower leaves. 1428 sunflower images dataset have been used for this purpose. K-means clustering used for segmentation and extract the characteristics for classification, then deep learning classifier used for detection of disease. Form above ResNet50 classifier performed best provided accuracy of 97.88% .

In this study the various advance deep learning model have been studied approximate 38 models were studied to get the accuracy in disease classification. Different advance deep learning model have been tested on sunflower, Agri-ImageNet and cauliflower dataset.

In comparison with other deep learning models EfficientNetV2B2 and EfficientNetV2B3 provide very good accuracy. It has been observed that InceptionResNetV2 behave as the standard benchmark, and EfficientNetV2B1, EfficientNetV2B2, and EfficientNetV2B3 are outstanding performance for identification of disease in plant. [39]

In this study [40] the author detects the disease of sunflower leaves. The author gave the hybrid approach of VGG-16 and MobileNet classifier on 329 images small dataset of sunflower leaves. If compare between the current approach and the approach given in this study, the approach given in this research win with the accuracy of 89.2%.

In this study [41] the author classifies upper and lower leaf side. the classification done using machine learning and deep learning model. various classification methods have been used one of them like RESNET50 and ResNet152 methods and the other one conducted with five

machine learning models. Color, shape and texture used for classification. Out of these approaches used the SVM has performed better than CNN. SVM provide better accuracy than CNN.

In this paper disease detection performed on oilseed leaves. It mainly focusses on oil segment of agriculture sector. The approach used for detection of disease current deep learning approach.

The plant village dataset has been used in this approach. the author used the hybrid approach of ResNet50 and LSTM. To reduce the overfitting problem ResNet50 model increased the feature from 4 to 128. The ResNet50-LSTM model has validation accuracy of 95.44% and ResNet50 model shows 93.45% accuracy in plant disease classification [7].

In this approach the Rider-CSA approach used for disease detection. it is designed with the combination of ROA and CSA. The given approach perform classification to detect disease in plants. The approach given in this research outperformed than other approaches and show the accuracy of 0.877.[8]

This study focusses on disease detection in rice plant. Main consideration of diseases is leaf blight, brown spot, leaf smut.in this approach VGGG-16 and R-CNN are used to extract features and when features have been extracted than it has been categorized using random forest classifier. It has been observed that accuracy of 97.3% has been obtained in detection and classification of rice disease as compared to other machine learning algorithm used for disease detection.[9]

In this method [43]deep learning is used for disease detection because deep learning provides better library for detection of disease in plants specially in image processing. Firstly, feature extraction performed after this segmentation and than classification done on dataset, it is based on the pattern extracted from infected leaves. This approach used the dataset of 87K images (RGB) inclusion of healthy and infected leaves and CNN classifier used for classification of images. This approach [44] detect two diseases early blight and late blight, these two diseases infect potato and tomato. ResNet9 model used for detection and plant village dataset has been used for detection purpose. Augmentation performed on training datatset of 3990 images and then hyperparameter optimization performed on test dataset of 1331 images. It has been observed that ResNet9 consider the shape of the leaf, green areas for disease prediction,

because of this consideration it performs better than other approaches and this approach shows the accuracy 99.25% .

Reference	Year	Model	Performance	Limitations
[1]	2022	CNN	Effective	Applied on small Dataset
[4]	2023	SMLR and PCA	Optimum combination	Prediction of yield at zonal level of Rajasthan only
[5]	2016	Hybrid Ensemble Approach	94.73%.	Simple approach
[13]	2022	Deep CNN	97.11%	Applied on mustard oilseeds only
[14]	2014	Image Processing	shows better performance in detection of fungal disease other than traditional techniques.	Not used GSM and remote sensing techniques
[15]	2020	Deep Learning	96%.	Multiclass disease can be detected
[10]	2023	Deep CNN	99.69%.	-
[2]	2022	CNN & K Means Clustering	93 %	Performance can be enhanced
[3]	2022	Deep CNN	95.28%.	Probabilistic Graphical model of DCNN can be used
[11]	2019	3D Deep Learning	Classification of disease 95.73%	Focused on fungal disease of soyabean only
[12]	2023	Remote Sensing UAV Review	-	-
[6]	2020	ML specially GBT	GBT and SVM demonstrated	Did comparison of machine

In this research [45] author detected the disease of cotton and dataset taken of 22 different types of disease that contain fungal, bacterial, viral, deficient in nutrient disease types. From many algorithms CNN performs better than other algorithm with the accuracy of 99.39% with minimal error.

3.Description of Topic:

The import of edible oil in India is increasing year by year. Imports of edible oil in india has been increased to 15.47 million tonnes in the first 11 months of year 2022-23 from 12.66. the 22.15 import growth has been registered in india[Sources:thehindustanbusinessline.com]. India is the largest importer of refined oil that is why import duty also cut off in 2021 by the government. [Sources:Economoc times]. So, by increasing the production of oilseed crops and by reducing the loss of crops by early and accurate detection of disease the economic loss can be prevented. Oil seed crops are most import crop of all crops, detection of disease in oilseed crops primary focus nowadays. Automatic disease detection using advanced techniques like machine learning and deep learning can help the farmer for identification of disease and farmer can take preventive measures to cure the disease. This research provides

socioeconomic benefit to the society.

3.1 Oilseed Crops:- Some of the prominent oilseed crops cultivated in India are:

1. Mustard (Brassica juncea): Mustard is one of the most widely grown oilseed crops in India. It is used for oil extraction and as a condiment in various dishes.

2. Groundnut (Peanut) (Arachis hypogaea): Groundnut is another important oilseed crop in India. Groundnut is grown in states like Gujarat, Andhra Pradesh, Tamil Nadu, and Karnataka.

3. Soybean (Glycine max): Soybean is an essential oilseed crop known for its high protein content. It is primarily grown in states like Madhya Pradesh, Maharashtra, and Rajasthan.

4. Sunflower (Helianthus annuus): Sunflower is cultivated for its oil-rich seeds. Sunflower is grown in different states of india.

These are some of the important oilseed crops grown in India, contributing significantly to the country's oilseed production.

3.2Fungal Disease in Oil Seed Crops:

As for fungal diseases affecting oilseed crops in India, several pathogens can cause various diseases. It has been found that the major part of disease in crops are due to fungi it is approximated 75 percent of total disease [10] and because of the disease the destruction of crops occurs. This is because the truth that fungal diseases are more commonly found in crops and thus need more attention from researchers. One more important point added that fungal disease symptoms are easily visible as compared to others and can be observed easily. RGB images can be used that are mostly used by various DL methods.

Some of the common fungal diseases that can affect oilseed crops include:

1. Sclerotinia Rot (White Mold): This fungal disease is caused by Sclerotinia sclerotium and affects various oilseed crops like mustard, sunflower, and soybean [13].

2. Alternaria Leaf Blight: Caused by Alternaria spp., this disease affects oilseed crops like mustard and sunflower [40].

3. Downy Mildew: Downy mildew caused by Peronospora parasitica can affect mustard and other brassica oilseed crops [15].

4. Rust Diseases: Different rust pathogens can infect oilseed crops, such as mustard and soybean [11].

5. Fusarium Wilt: This disease caused by Fusarium spp. can affect oilseed crops like groundnut [3] and sesame.

6. Charcoal Rot: Charcoal rot, caused by Macrophomina phaseolina, can affect oilseed crops like soybean and groundnut [6].

3.3 Major Fungal Disease in Oilseed crops:

The major fungal diseases found in oil seeds are Alternaria leaf spot and blight (Alternaria spp.), Septoria Leaf Spot, White Rust , Downy Mildew, Powdery Mildew ,Black Rot, Club Root, Sclerotinia Stem Rot, Anthracnose (Colletotrichum spp.), Damping-off, Fusarium Root Rot, Black leg . The above mentioned diseases are some of the most harmful fungi, due to this significant crop loss, also declines in quantity, quality, and market value of crops. Due to declination in quality of oilseed crops or destruction of oil seeds crops because of fungal disease the economic loss occurs. To prevent from fungal disease early and accurate disease detection automation techniques must be needed.

4.Objectives of the Study

- To do a review the various existing methods of Deep Learning (DL) used for disease identification in oilseeds segment.
- To develop a novel deep learning technique for prediction of fungal disease in oilseeds.
- To develop an ensemble-based approach for prediction and classification of fungal disease in oil seeds.

5.Methodology to be adopted

5.1DataCollection:

High-resolution images of oilseed crops affected by various fungal diseases dataset will be collected. The dataset can be collected from research institutions, agricultural databases, or collaborations with local farmers and agricultural experts.

In dataset multiple oilseed crop species, such as soybeans, sunflower, and mustard, peanuts etc. to ensure the applicability of the models across different crops.

To minimizing bias and ensure accurate representation, the dataset will include a balanced number of images of healthy plants and those impacted by various fungal diseases, such as powdery mildew, rust, leaf spot, and blight.

5.2 Data Preprocessing:

Preprocessing of data is very important to process the images or extract the features and prepare them for the use of various deep learning techniques. The size of images will be changed to a consistent resolution to decrease complexity in computation and to maintain uniformity during training.

Color techniques normalization, such as histogram equalization, will be applied to reduce variations in lighting conditions and color intensity across images.

Different data augmentation techniques like Rotation, flipping, and zooming will be used to augment the dataset, increasing the variety and large number of samples available for training and testing ,improving generalization of model .

5.3 Deep Learning Models:

Convolutional Neural Networks (CNNs): Deep learning models specially CNNs are a popular choice for image recognition tasks due to their ability to automatically learn hierarchical features from images.

Recurrent Neural Networks (RNNs): RNNs can capture temporal dependencies in sequential data, which may be relevant for detecting the progression of fungal diseases in plant images.

Transfer Learning: Pre-trained CNN models, such as VGG, ResNet, or Inception, will also be considered to leverage their learned features and adapt them to the specific fungal disease detection task.

5.4Model Training and Evaluation:

In this stage the deep learning models will be evaluated on trained and test dataset and then performance will be measured by using different parameter metrics.

During the training phase, the models will be fed with the preprocessed images, and their parameters will be updated iteratively to minimize the loss function.

Hyperparameter tuning will be conducted to optimize the performance of the models, including learning rate, batch size, and number of layers.

The trained models will be evaluated on the testing set using standard evaluation metrics such as accuracy, precision, recall, F1-score, and AUC-ROC.

5.5Comparison and Analysis:

The performance metrics of different deep learning models will be compared to identify the most accurate and efficient approach for fungal disease detection in oilseed crops.

The computational requirements and training times for each model will be analyzed to consider their practical applicability in real-world scenarios.

Visualizations, such as confusion matrices and precision-recall curves, will be used to provide further insights into the models' strengths and weaknesses.

5.6Results:

This research will be interpreted and discussed in the interest of practical applicability, scalability, and potential challenges faced during implementation in real agricultural settings.

Insights gained from the study will be used to propose recommendations for future research and potential improvements to the fungal disease detection system.

6.Expected Outcome of the Research

This research will contribute to the provide an efficient and automated fungal disease detection system for oilseed crops. Implementing such technology in agricultural practices can lead to early disease detection, targeted treatment, and ultimately improved crop productivity and economic sustainability.

By swiftly identifying fungal diseases, this technology enables timely interventions, ultimately reducing crop losses and enhancing food security.

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Supervisor: Dr. Parneeta Dhaliwal Department: CS.T

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ABSTRACT

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Oilseed crops are essential sources of edible oils, biofuels, and animal feed globally. However, they are highly susceptible to fungal infections, which can drastically impact crop productivity. Early and accurate detection of fungal diseases in oilseed crops are crucial for maintaining agricultural sustainability and ensuring food security. Deep learning, a subfield of artificial intelligence, has demonstrated remarkable performance in image recognition tasks in recent years, making it a potential solution for automated crop disease detection.

Keywords: Deep Learning, Oilseed Crops, Fungal Diseases, Disease Detection, Agriculture Sustainability.

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